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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : C07C 335/32, 311/29, 311/21, 257/18, 275/40, 235/20, A61K 31/63, 31/155, 31/17	A3	(11) International Publication Number: WO 98/45259 (43) International Publication Date: 15 October 1998 (15.10.98)
(21) International Application Number: PCT/US98/06152 (22) International Filing Date: 1 April 1998 (01.04.98) (30) Priority Data: 60/043,232 10 April 1997 (10.04.97) US (71) Applicant (for all designated States except US): PHARMACIA & UPJOHN COMPANY [US/US]; 301 Henrietta Street, Kalamazoo, MI 49001 (US). (72) Inventors; and (73) Inventors/Applicants (for US only): BARBACHYN, Michael, R. [US/US]; 1216 Miles Avenue, Kalamazoo, MI 49001 (US). HOMA, Fred, L. [US/US]; 3430 Pine Grove Lane, Kalamazoo, MI 49008 (US). MONGE, Antonio [ES/ES]; Esquiroz Bidea 3, E-31180 Cizur Menor (ES). SANTIAGO, Esteban [ES/ES]; Tudela 22, 4°, E-31003 Pamplona (ES). MARTINEZ-IRUJO, Juan, J. [ES/ES]; González Tablas 6, 5° Izda, E-31003 Pamplona (ES). FONT, Maria [ES/ES]; Navas de Tolosa 27, 4° A, E-31001 Pamplona (ES). (74) Agent: YANG, Lucy, X.; Pharmacia & Upjohn Company, Intellectual Property Legal Services, 301 Henrietta Street, Kalamazoo, MI 49001 (US).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CY, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> (88) Date of publication of the international search report: 25 February 1999 (25.02.99)
(54) Title: POLYAROMATIC ANTIVIRAL COMPOSITIONS (57) Abstract The present invention relates to polyaromatic compounds having useful antiviral activity against viruses of the herpes family, to a composition containing them, and to a method of using them for the treatment of herpes viruses infections.		

*(Referred to in PCT Gazette No. 49/1998, Section II)

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/06152

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C07C335/32 C07C311/29 C07C311/21 C07C257/18 C07C275/40
C07C235/20 A61K31/63 A61K31/155 A61K31/17

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C07C A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CHEMICAL ABSTRACTS, vol. 90, no. 2, 8 January 1979 Columbus, Ohio, US; abstract no. 6722, XP002075334 see abstract & R.A. BRAND ET AL: J. POLYM. SCI., POLYM. CHEM. ED., vol. 16, no. 9, 1978, pages 2275-2284, -& DATABASE DARC QUESTEL, LE CAPITOLE, NANTERRE, FR XP002075336 registry no. 68575-17-7 see abstract --- -/--	1,3

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

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- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

24 August 1998

Date of mailing of the international search report

12. 11. 98

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Kapteyn, H

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/06152

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 611 754 A (NIPPON PAPER INDUSTRIES CO., LTD.) 24 August 1994 cited in the application see claim 1	1
A	EP 0 498 095 A (MERRELL DOW PHARMACEUTICALS INC.) 12 August 1992 see claim 1	5
A	EP 0 380 048 A (ISHIHARA SANGYO KAISHA LTD.) 1 August 1990 see claim 7	5
A	WO 88 00828 A (CHEMISCHE FABRIK STOCKHAUSEN GMBH) 11 February 1988 see claim 1	5
A	WO 82 03390 A (CIBA-GEIGY AG) 14 October 1982 see claim 1	1
A	PATENT ABSTRACTS OF JAPAN vol. 5, no. 184 (C-080), 21 November 1981 & JP 56 108759 A (MITSUI TOATSU CHEM INC), 28 August 1981 see abstract	1
A,P	CHEMICAL ABSTRACTS, vol. 126, no. 17, 28 April 1997 Columbus, Ohio, US; abstract no. 220325v, XP002075335 see abstract	5
A	& N. NEAMATI ET AL: ANTIMICROB. AGENTS CHEMOTHER, vol. 41, no. 2, 1997, pages 385-393, -----	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 98/06152

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims: 1,3,5,7 and 8-14 partially
2. Claims: 2,4,6 and 8-14 partially

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1,3,5,7 and 8-14 partially

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 98/06152

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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(54) Title: POLYAROMATIC ANTIVIRAL COMPOSITIONS (57) Abstract The present invention relates to polyaromatic compounds having useful antiviral activity against viruses of the herpes family, to a composition containing them, and to a method of using them for the treatment of herpes viruses infections.		

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POLYAROMATIC ANTIVIRAL COMPOSITIONS

FIELD OF THE INVENTION

The present invention relates to polyaromatic compounds having useful
 5 antiviral activity against viruses of the herpes family, to a composition containing
 them, and to a method of using them for the treatment of herpes viral infections.

BACKGROUND OF THE INVENTION

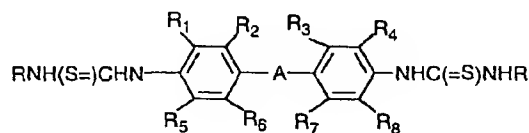
Viruses are made of nucleic acid (DNA or RNA) enclosed in a protein coat
 10 and sometimes further wrapped in a membranous envelope. Viruses are obligate
 intracellular parasites; they can only reproduce within a host cell. An isolated virus
 is unable to replicate itself, or do anything else for that matter, except infect an
 appropriate host cell. Of the DNA viruses, the herpes family is the source of the
 most common viral illnesses in man. The group consists of herpes simplex viruses
 15 type-1 and type-2 (HSV-1 and HSV-2), varicella zoster virus (VZV), cytomegalovirus
 (CMV), and Epstein-Barr virus (EBV). We have discovered that certain
 polyaromatic compounds characterized by formulas I, II, and III have potent
 antiviral activity against the herpes family, particularly against herpes simplex
 viruses. These compounds inhibit the origin-specific DNA-binding protein, an
 20 essential herpes virus replication protein, binding to the origin of viral DNA
 replication. As such, the compounds inhibit the initiation of herpes viral DNA
 synthesis in the host cell. Because of this unique mechanism, the compounds not
 only exhibit potent activity against herpes viruses but also are active against viral
 strains resistant to currently available therapeutic agents.

25

INFORMATION DISCLOSURE

European Patent Application 0,611,754 A1 discloses derivatives of dimerized
 thiourea having the structure:

30

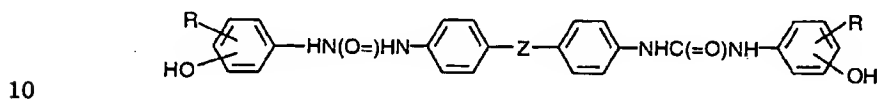


35 wherein

A is, among others, CH₂, S, O, or SO₂;

R is, among others, a substituted or unsubstituted aryl group having 6 to 30 carbon; R₁, R₂, R₃, R₄, R₅, R₆, R₇, and R₈ are the same and different and are C₁₋₆ alkyl, NO₂, CN, H or halogen. The compounds are disclosed as being useful to prepare a near infrared resin material.

- 5 UK Patent Application GB 2,290,626 discloses, among others, bisurea compound of the structure:

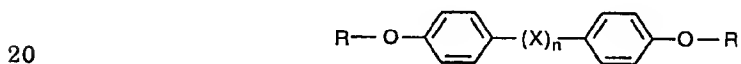


wherein

Z is CH₂, O, SO₂ or NH;

- R is H, halogen, NO₂, C₁₋₁₂ alkyl, C₁₋₆ haloalkyl or C₁₋₆ alkoxy. Such compounds
15 are described as being useful to prepare a thermal recording material.

U.S. Patent 5,500,322 discloses, among others, a developer additive having the structure:

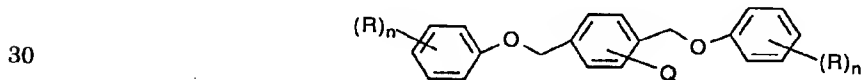


wherein

X is, among others, S, SO₂, O or CH₂;

- R is an alkyl group, an alkenyl group or an arylalkyl group. Such compounds are
25 described as being used in a toner composition.

European Patent Application 0,519,702 A1 discloses, among others, compound of the structure:



wherein

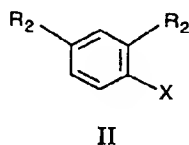
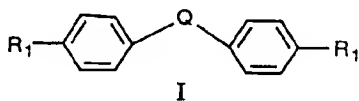
Q is H, halogen, nitro, C₁₋₆ alkyl, C₁₋₆ perhaloalkyl, C₁₋₆ alkylthio or C₁₋₆ alkyl sulfonyl;

- 35 R is, among others, C₁₋₁₀ alkyl, alkoxy, or halogen;
n is one to three. Such compounds are described as being active against

picornaviruses including enteroviruses and rhinoviruses.

SUMMARY OF THE INVENTION

In one aspect, the present invention provides a compound of formula I and
 5 formula II or pharmaceutically acceptable salts thereof having useful antiviral activity against viruses of the herpes family



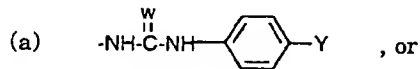
wherein:

Q is O, or CH₂;

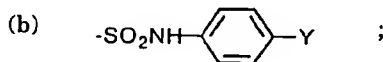
R₁ is (a) -N=C(SCH₃)(NH-phenyl), (b) -N=C(SCH₃)(NHCH₂CH₂-phenyl),
 20 (c) -N=C(SCH₃)(NH-4-nitrophenyl), (d) -N=C(SCH₂CH₃)(NHCH₂CH₂-phenyl),
 (e) -SO₂NH(3-methoxyphenyl), (f) -SO₂NH(3-methylphenyl), or
 (g) -N=C(NH₂)(phenyl); with the provisos that where Q is O, R₁ and R₂ are other than (g), and where Q is CH₂, R₁ and R₂ are other than (a) - (f);

R₂ is

25



30



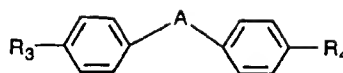
W is O, or S;

X is H, CH₃, OCH₃;

Y is CH₃, Cl, and NO₂.

In another aspect, the present invention provides a method for treating
 35 herpes viral infections which comprises an effective amount of a compound of formula II or formula III, wherein formula II is the same as defined above and

formula III having the structure:



III

wherein A is O, CH₂, or S(=O)₂;

R₃ and R₄ are the same and are

- 10 (a) -N=C(SCH₃)(NH-phenyl), (b) -N=C(SCH₃)(NHCH₂CH₂-phenyl),
 (c) -N=C(SCH₃)(NH-4-nitrophenyl), (d) -N=C(SCH₂CH₃)(NHCH₂CH₂-phenyl),
 (e) -SO₂NH(3-methoxyphenyl), (f) -SO₂NH(3-methylphenyl),
 (g) -N=C(NH₂)(phenyl), (h) -NHC(=O)(2-furyl),
 (i) -NHC(=S)NHCH₂CH₂-phenyl, (j) -NHC(=S)NH(4-nitrophenyl),
 15 (k) -OCH₂(4-bromophenyl), (l) -OCH₂(4-chlorophenyl),
 (m) -OCH₂(4-fluorophenyl), (n) -OCH₂(4-pyridyl), or
 R₃ and R₄ are different and are (o) -OH, (p) -OCH₂(4-chlorophenyl),
 (q) -OCH₂(4-nitrophenyl); with the provisos that where A is -O-, R₃ and R₄ are other
 than (k) - (q), where A is -CH₂-, R₃ and R₄ are (g) or (j), and where A is S(=O)₂, R₃
 20 and R₄ are other than (a) - (j).

In still another aspect, the present invention provides a pharmaceutical composition for treating herpes viral infections which comprises an effective amount of a compound of formula II or III and a pharmaceutically acceptable carrier.

The compounds of formulas I, II and III include

- 25 a) Dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(phenyl)carbamimidothioate],
 b) Dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)
 carbamidimidothioate],
 c) Dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)
 carbamidimidothioate],
 30 d) Diethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)carbamimidothioate],
 e) Bis[*N'*-(3-methoxyphenyl)aminosulfonyl](oxydi-4,1-phenylene),
 f) Bis[*N'*-(3-methylphenyl)aminosulfonyl](oxydi-4,1-phenylene),
 g) *N,N'*-(Methylenedi-4,1-phenylene)bis[benzenecarboximidamide],
 h) *N,N'*-(4-Methoxy-1,3-phenylene)bis[*N'*-(4-nitrophenyl)urea],
 35 i) *N,N'*-(4-Methoxy-1,3-phenylene)bis[*N'*-(4-chlorophenyl)urea],

- j) *N,N''*-(4-Methoxy-1,3-phenylene)bis[*N'*-(*p*-tolyl)urea],
- k) *N,N''*-(4-Methyl-1,3-phenylene)bis[*N'*-(4-chlorophenyl)thiourea],
- l) *N,N''*-(4-Methoxy-1,3-phenylene)bis[*N'*-(4-chlorophenyl)thiourea],
- m) *N,N''*-(4-Methoxy-1,3-phenylene)bis[*N'*-(4-nitrophenyl)thiourea],
- 5 n) *N,N''*-(1,3-Phenylene)bis[*N'*-(*p*-tolyl)aminosulfonyl],
- o) *N,N''*-(Oxydi-4,1-phenylene)bis(2-furancarboxamide),
- p) *N,N''*-(Oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)thiourea],
- q) *N,N''*-(Oxydi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)thiourea],
- r) *N,N''*-(Methylenedi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)thiourea],
- 10 s) Bis(4-bromobenzyloxy)(sulfonyldi-4,1-phenylene),
- t) Bis(4-chlorobenzyloxy)(sulfonyldi-4,1-phenylene),
- u) Bis(4-fluorobenzyloxy)(sulfonyldi-4,1-phenylene),
- v) Bis[(4-pyridyl)methoxy](sulfonyldi-4,1-phenylene),
- w) (4-Chlorobenzyloxy)hydroxy(sulfonyldi-4,1-phenylene), and
- 15 x) Hydroxy(4-nitrobenzyloxy)(sulfonyldi-4,1-phenylene).

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to polyaromatic compounds, their compositions and their use in medical therapy for the treatment of herpes viral infections including herpes simplex viruses type-1 and type-2 (HSV-1 and HSV-2), varicella zoster virus (VZV), cytomegalovirus (CMV), and Epstein-Barr virus (EBV). The compounds of the present invention are topically administered to the surface lesion caused by the herpes viruses.

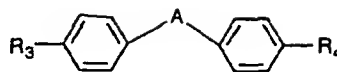
Herpes viruses infections are recurrent infections characterized by the appearance on the skin or mucous membranes of multiple clusters of small vesicles, filled with clear fluid on slightly raised inflammatory bases. The present invention can also be applied prophylactically to prevent further recurrences of the viral lesions.

Patients of the present invention are chosen from those having been diagnosed with primary or recurrent herpes simplex type 1 or 2, herpes zoster, genital warts, chickenpox, or herpes keratitis. Such diseases and conditions are well known and readily diagnosed by physician of ordinary skill.

Topical administration means the direct contact of the active agents with the surface lesion such as, for example, by drops, sprays, ointments, lotions, creams or soaps.

The active compound or its composition is applied 1 to 5 times daily until the

formula III having the structure:



5

III

wherein A is O, CH₂, or S(=O)₂;

R₃ and R₄ are the same and are

- 10 (a) -N=C(SCH₃)(NH-phenyl), (b) -N=C(SCH₃)(NHCH₂CH₂-phenyl),
 (c) -N=C(SCH₃)(NH-4-nitrophenyl), (d) -N=C(SCH₂CH₃)(NHCH₂CH₂-phenyl),
 (e) -SO₂NH(3-methoxyphenyl), (f) -SO₂NH(3-methylphenyl),
 (g) -N=C(NH₂)(phenyl), (h) -NHC(=O)(2-furyl),
 (i) -NHC(=S)NHCH₂CH₂-phenyl, (j) -NHC(=S)NH(4-nitrophenyl),
 15 (k) -OCH₂(4-bromophenyl), (l) -OCH₂(4-chlorophenyl),
 (m) -OCH₂(4-fluorophenyl), (n) -OCH₂(4-pyridyl), or
 R₃ and R₄ are different and are (o) -OH, (p) -OCH₂(4-chlorophenyl),
 (q) -OCH₂(4-nitrophenyl); with the provisos that where A is -O-, R₃ and R₄ are other
 than (k) - (q), where A is -CH₂-, R₃ and R₄ are (g) or (j), and where A is S(=O)₂, R₃
 20 and R₄ are other than (a) - (j).

In still another aspect, the present invention provides a pharmaceutical composition for treating herpes viral infections which comprises an effective amount of a compound of formula II or III and a pharmaceutically acceptable carrier.

The compounds of formulas I, II and III include

- 25 a) Dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(phenyl)carbamimidothioate],
 b) Dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)
 carbamidithioate],
 c) Dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)
 carbamidithioate],
 30 d) Diethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)carbamimidothioate],
 e) Bis[*N'*-(3-methoxyphenyl)aminosulfonyl](oxydi-4,1-phenylene),
 f) Bis[*N'*-(3-methylphenyl)aminosulfonyl](oxydi-4,1-phenylene),
 g) *N,N'*-(Methylenedi-4,1-phenylene)bis[benzenecarboximidamide],
 h) *N,N'*-(4-Methoxy-1,3-phenylene)bis[*N'*-(4-nitrophenyl)urea],
 35 i) *N,N'*-(4-Methoxy-1,3-phenylene)bis[*N'*-(4-chlorophenyl)urea],

- j) *N,N'*-(4-Methoxy-1,3-phenylene)bis[*N'*-(*p*-tolyl)urea],
- k) *N,N'*-(4-Methyl-1,3-phenylene)bis[*N'*-(4-chlorophenyl)thiourea],
- l) *N,N'*-(4-Methoxy-1,3-phenylene)bis[*N'*-(4-chlorophenyl)thiourea],
- m) *N,N'*-(4-Methoxy-1,3-phenylene)bis[*N'*-(4-nitrophenyl)thiourea],
- 5 n) *N,N'*-(1,3-Phenylene)bis[*N*-(*p*-tolyl)aminosulfonyl],
- o) *N,N'*-(Oxydi-4,1-phenylene)bis(2-furancarboxamide),
- p) *N,N'*-(Oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)thiourea],
- q) *N,N'*-(Oxydi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)thiourea],
- r) *N,N'*-(Methylenedi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)thiourea],
- 10 s) Bis(4-bromobenzyloxy)(sulfonyldi-4,1-phenylene),
- t) Bis(4-chlorobenzyloxy)(sulfonyldi-4,1-phenylene),
- u) Bis(4-fluorobenzyloxy)(sulfonyldi-4,1-phenylene),
- v) Bis[(4-pyridyl)methoxy](sulfonyldi-4,1-phenylene),
- w) (4-Chlorobenzyloxy)hydroxy(sulfonyldi-4,1-phenylene), and
- 15 x) Hydroxy(4-nitrobenzyloxy)(sulfonyldi-4,1-phenylene).

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to polyaromatic compounds, their compositions and their use in medical therapy for the treatment of herpes viral infections including herpes simplex viruses type-1 and type-2 (HSV-1 and HSV-2), varicella zoster virus (VZV), cytomegalovirus (CMV), and Epstein-Barr virus (EBV). The compounds of the present invention are topically administered to the surface lesion caused by the herpes viruses.

Herpes viruses infections are recurrent infections characterized by the appearance on the skin or mucous membranes of multiple clusters of small vesicles, filled with clear fluid on slightly raised inflammatory bases. The present invention can also be applied prophylactically to prevent further recurrences of the viral lesions.

Patients of the present invention are chosen from those having been diagnosed with primary or recurrent herpes simplex type 1 or 2, herpes zoster, genital warts, chickenpox, or herpes keratitis. Such diseases and conditions are well known and readily diagnosed by physician of ordinary skill.

Topical administration means the direct contact of the active agents with the surface lesion such as, for example, by drops, sprays, ointments, lotions, creams or soaps.

The active compound or its composition is applied 1 to 5 times daily until the

sore, lesion, and accompanying discomfort abates and essentially disappears.

The pharmaceutical compositions of this invention may be prepared by employing conventional technique to combine the compounds of formula II or III of this invention with a pharmaceutically acceptable carrier, and optionally, with
5 pharmaceutically acceptable adjuvants and excipients employing standard and conventional techniques. The topical formulations may also desirably include a material which enhances absorption or penetration of the compounds of formula II or III through the skin or other affected areas.

The pharmaceutically acceptable carrier refers to any compatible non-toxic
10 material suited for mixing with the active compounds of the present invention.

The quantity of active component, compounds of formula II or III, in a pharmaceutical composition may be varied or adjusted widely depending upon the requirements of the patient, the severity of viral infections, the potency of the particular compound being used, the particular formulation and the desired
15 concentration. Generally, the quantity of active component will range between 0.05% to 25% by weight of the composition, preferably between 0.1% to 10% by weight of the composition.

For infections of the external tissues, e.g., mouth, eyes and skin, the formulations are preferably applied as a topical ointment or cream containing the
20 active ingredient in an amount of, for example, 0.05 to 25% by weight of composition, preferably 0.1 to 10% w/w. When formulated in an ointment, the active ingredients may be employed with either a paraffinic or a water-miscible ointment base. Alternatively, the active ingredients may be formulated in a cream with an oil-in-water cream base.

25 Formulations suitable for topical administration in the eyes include eye drops wherein a compound of formula II or III is dissolved or suspended in a suitable carrier, especially an aqueous solvent. The active ingredient is preferably present in such formulations in a concentration of 0.05 to 25%, advantageously 0.5 to 10%.

Formulations suitable for topical administration in the mouth include
30 lozenges comprising the active ingredient in a flavored basis, usually sucrose and acacia or tragacanth; pastilles comprising the active ingredient in an inert basis such as gelatin and glycerin, or sucrose and acacia; and mouth-washes comprising the active ingredient in a suitable liquid carrier.

The term "pharmaceutically acceptable salts" refers to salts useful for
35 administering the compounds of this invention and include hydrochloride, hydrobromide, hydroiodide, sulfate, phosphate, acetate, propionate, lactate,

mesylate, maleate, malate, succinate, tartrate, citric acid, 2-hydroxyethyl sulfonate, fumarate and the like. These salts may be in hydrated form.

Compounds of the formulas II and III of the present invention are evaluated in an assay to measure the inhibition of HSV-1 viral replication in the presence of
5 drug over a 14-16 hour period. The assay is discussed in detail by Pritchard, M.N. et al. "A Microliter Virus Yield Reduction Assay for the Evaluation of Antiviral Compounds Against Human Cytomegalovirus and Herpes Simplex Virus", *J. Virol. Meth.*, Vol. 28, pp 101-106 (1990). Briefly, 80% confluent monolayers of Vero cells in
10 24 well plates are infected with low multiplicities of HSV-1 (MOI = .001). After an absorption period of 1 hour at 37 °C, the monolayers are rinsed with culture media and aliquots of compounds diluted into tissue culture media are added for 14-16 hours at 37 °C in a CO₂ atmosphere. The growth media is removed and 1 ml of fresh media is added to each well and plates are placed at -70 °C. After a 1-5 day storage period the plates are rapidly thawed, samples are collected on ice and
15 titrated on fresh Vero cell monolayers. Viral plaques are stained with 0.1% crystal violet in 20% alcohol for 10 minutes and are counted. Data are calculated to reflect the percentage of inhibition at indicated concentration relative to infected, non-drug treated controls.

Compounds of the formulas II and III of the present invention are also
20 evaluated in substantially the same assay as described above to measure the inhibition of HSV-2 viral replication.

Antiviral activity against VZV are evaluated in an assay to measure the reduction of viral replication in the number viral plaques formed over five days of incubation in the presence of compounds of the present invention. Aliquots of VZV
25 are added for 90 minutes to 24 well plates having HFF cells at 80% confluence to yield approximately 25 plaques for media treated wells. The plates are flicked and dilutions of compounds in tissue culture media at 2 time strength are added (0.5 ml per well). Immediately following the addition of drug 0.5 ml of 1.0% agarose is added to the wells and the plates are gently tapped to aid mixing. This final
30 concentration of agarose (0.5%) is insufficient to solidify at 37 °C and serves as a semi solid overlay medium. Plates are undisturbed for five days. On day 5 the plates are examined microscopically for toxicity and plaques are counted using low power microscopy.

In the Tables, the sign "+++" refers to >90% inhibition at the indicated
35 concentration. The sign "++" refers to > 50% inhibition at the indicated concentration. The sign "+" refers to <50% inhibition at the indicated concentration.

The sign "-" refers that no inhibitory activity is observed at the indicated concentration. A blank cell means the datum is not available.

Table 1 lists the corresponding level of inhibition against HSV-1 replication.

Table 2 lists the corresponding level of inhibition against HSV-2 replication.

5 Table 3 lists the corresponding level of inhibition against VZV replication.

TABLE 1
% Inhibition Against HSV-1 Viral Replication

Example No.	30 μ m	5 μ m
10 1	+	-
2	++	-
3	+	+
4	+	+
5	+	-
15 6	+	-
7	+	-
8	+	-
9	+++	+
10	++	+
20 11	++	-
12	+++	++
13	+++	+
14	+	-
15	+	+
25 16	++	+
17	++	+
18	++	+

19	+	+
20	++	+
21	++	-
22	++	-
23	+++	-

TABLE 2

% Inhibition Against HSV-2 Viral Replication

Example No.	10 μ m	1 μ m
12	++	+
13	+++	+
15	+	+
17	++	++

TABLE 3

% Inhibition Against VZV Viral Replication

Example No.	10 μ m	2 μ m
12		+++
13		+
15		+++
17		++
18	+++	
23	+	

The compounds of the present invention may be prepared by the synthetic procedures illustrated in SCHEMEs 1-3.

As shown in SCHEME 1A, diamine 1 or 2, (when necessary it can be generated from the corresponding acid addition salt by treatment *in situ* with triethylamine) can be reacted with two equivalents of an appropriate isocyanate or isothiocyanate wherein R is R₁, R₂, R₃, or R₄ and is as defined above; X is as
5 defined above. The reaction occurs in a suitable solvent system, such as anhydrous dioxane, at room temperature to generate the bisurea (Y = O) or bithiourea (Y = S) derivatives 3 or 4, respectively.

The bithiourea derivatives (Y = S) can be alkylated with a suitable alkylating agent, for example iodomethane, in an appropriate solvent such as
10 ethanol, and at ambient temperature to reflux temperature to generate the dimethyl carbamimidothioates 5 or 6, respectively.

As shown in SCHEME 1B, diamine 1 or 2 may also be reacted with imidates in a suitable solvent such as dioxane in the presence of acetic acid and sodium acetate at ambient temperature to generate the carboximidamides 7 or 8,
15 respectively.

As shown in SCHEME 1C, the diamine 1 or 2 are also amenable to acylation with various acyl halide in the presence of a suitable base such as triethylamine and in an appropriate solvent, for example dichloromethane, at ambient temperature to give the corresponding bisamide 9 or 10.

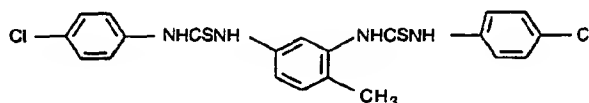
20 The sulfonyl chlorides, 11 and 12 shown in SCHEME 2, are known compounds. Reaction of 11 or 12 with a suitable amine in the presence of an appropriate base such as pyridine and in a solvent such as dichloromethane at ambient temperature affords the corresponding sulfonamide derivatives 13 or 14, respectively.

25 As shown in SCHEME 3, bis-hydroxyphenyl 15 is readily alkylated with an appropriate arylhalomethanes in the presence of a suitable base, such as potassium hydroxide, and in an appropriate solvent such as dimethyl sulfoxide at ambient temperature to generate the derivatives 17. Alternatively, bis-hydroxyphenyl 15 is monoalkylated with an appropriate arylhalomethane in the presence of a suitable
30 base, such as triethylamine, and in an appropriate solvent such as dry dioxane at reflux temperature to generate the derivatives 16.

The followings are the examples for the preparation, which is intended as an illustration of and not a limitation upon the scope of the invention.

Example 1 Preparation of *N,N'*-(4-methyl-1,3-phenylene)bis[*N'*-(4-chlorophenyl)thiourea].

5



A solution of 4-chlorophenylisothiocyanate (1.39 g, 8.20 mmol) in dry dioxane (20 mL) is added dropwise, under nitrogen atmosphere, to a solution of 2,4-diaminotoluene (0.5 g, 4.10 mmol) in dry dioxane (20 mL). After 72 hours of stirring at room temperature the mixture is heated to 80 °C for 6 hours, and the solvent is eliminated under reduced pressure. The oily residue obtained is stirred with IsprOH (25 mL) for 4 hours. The white solid that precipitates is filtered and washed with n-hexane (3 x 25 mL) and ethyl ether (3 x 25 mL). The title compound is obtained as white powder. mp: 93-95 °C.

¹H-NMR (DMSO-d₆, 200 MHz) δ: 2.29; 7.15-7.25; 7.34; 7.47; 9.55; 9.61; 9.67; 9.93.

IR: 1580 cm⁻¹.

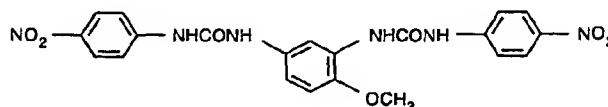
MS-DIP (70 eV) m/z: 291.00; 168.95; 127.00.

ANAL: (C₂₁H₁₈Cl₂N₄S₂) C: Calcd, 54.66; Found, 54.41. H: Calcd, 3.90; Found, 3.92.

N: Calcd, 12.14; Found, 11.85.

Example 2 Preparation of *N,N'*-(4-methoxy-1,3-phenylene)bis[*N'*-(4-nitrophenyl)urea].

25



A solution of 4-nitrophenylisocyanate (1.39 g, 8.47 mmol) in dry dioxane (20 mL) is added dropwise, under N₂ atmosphere and with constant magnetic stirring, to a solution of 4-methoxy-m-phenyldiaminesulfate hydrate (1.00 g, 4.23 mmol) in dry dioxane (25 mL) and in the presence of triethylamine (1.2 mL). After 100 hours of stirring at room temperature, a precipitate appears. This precipitate is filtered and washed with H₂O (5 x 25 mL). The resulting solid is suspended in IsprOH (30 mL) and stirred at room temperature for 7 hours. It is filtered and washed successively with n-hexane (3 x 50 mL) and ethyl ether (3 x 50 mL). It is then

dried. The title compound is obtained as yellow hygroscopic powder.

mp: 180-82 °C.

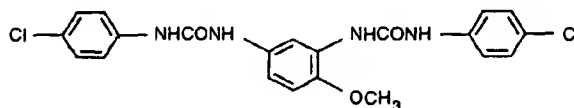
¹H-NMR (DMSO- d₆, 200 MHz) δ: 3.86; 6.99-7.19; 7.69; 8.23; 8.46; 8.87; 9.27; 10.05.

IR: 1686 cm⁻¹.

- 5 ANAL: (C₂₁H₁₈N₆O₇ · 3/4 H₂O) C: Calcd, 52.55; Found, 52.34 H: Calcd, 4.07
Found, 4.21. N: Calcd, 17.52; Found, 17.32.

Example 3 Preparation of *N,N'*-(4-methoxy-1,3-phenylene)bis[*N'*-(4-chlorophenyl)urea].

10



- 15 A solution of 4-chlorophenylisocyanate (1.30 g, 8.20 mmol) in dry dioxane (20 mL) is added dropwise, under N₂ atmosphere, to a solution of 4-methoxy-m-phenylenediaminesulfate hydrate (1.00 g, 4.23 mmol) in dry dioxane (20 mL) and in the presence of triethylamine (1.2 mL). After 72 hours of stirring at room temperature, a white precipitate appears. This precipitate is filtered and washed
20 with H₂O (5 x 25 mL). The resulting solid is suspended in ethanol (30 mL) and stirred at room temperature for 3 hours. It is then filtered and recrystallized. The title compound is obtained as white powder. mp: >300 °C.

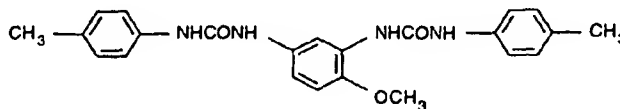
¹H-NMR (DMSO-d₆, 200 MHz) δ: 3.85; 6.94; 7.20; 7.30-7.35; 7.50; 8.20; 8.27; 8.62; 9.49.

- 25 IR: 3297; 1638 cm⁻¹.

ANAL: (C₂₁H₁₈Cl₂N₄O₃) C: Calcd, 56.63; Found, 56.54. H: Calcd, 4.04, Found, 4.06. N: Calcd, 12.58; Found, 12.41.

Example 4 Preparation of *N,N'*-(4-methoxy-1,3-phenylene)bis[*N'*-(*p*-tolyl)urea].

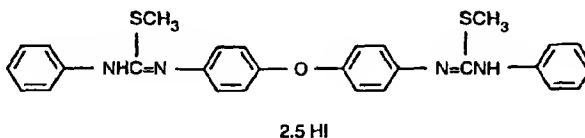
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- 35 A solution of *p*-tolylisocyanate (1.12 g, 8.42 mmol) in dry dioxane (20 mL) is added dropwise, under N₂ atmosphere and with constant stirring, to a solution of

4-methoxy-m-ph nylendiaminesulfate hydrate (1.00 g, 4.23 mmol) in dry dioxane (25 mL) and in the presence of triethylamine (1.2 mL). After 150 hours of stirring at room temperature, a precipitate appears. This precipitate is filtered and washed with H₂O (5 x 25 mL). The resulting solid is suspended in EtOH (30 mL) and
 5 stirred at room temperature for 4 hours. It is then filtered, washed successively with n-hexane (3 x 50 mL) and ethyl ether (3 x 50 mL), and dried. The title compound is obtained as white hygroscopic powder. mp: 162-64 °C.
¹H-NMR (DMSO-d₆, 200 MHz) δ 2.24; 3.84; 6.92; 7.05-7.93; 7.22; 7.33; 8.19; 8.36; 8.51; 9.24.
 10 IR: 3296; 1640 cm⁻¹.
 ANAL: (C₂₃H₂₄N₄O₃) C: Calcd, 68.32; Found, 67.96. H: Calcd, 5.94; Found 5.62. N: Calcd, 13.86; Found, 14.19.

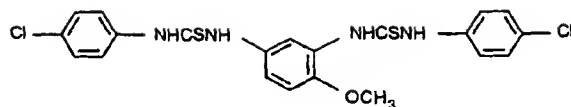
Example 5 Preparation of dimethyl *N,N'*-(oxydi-4,1-phenylene)bis
 15 [*N'*-(phenyl) carbamimidothioate].



A solution of iodomethane (0.9 g, 6.4 mmol) is added dropwise to a solution of *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(phenyl)thiourea] (0.5 g, 1.06 mmol) in ethanol (20 mL) at room temperature and with constant stirring. After 30 minutes of stirring
 25 at room temperature, the mixture is heated to reflux for 5 hours, observing total dissolution. The solvent is removed under reduced pressure and the resulting solid is recrystallized (EtOH), and the title compound is obtained as yellow powder. mp: 90 °C.

¹H-NMR (DMSO-d₆, 200 MHz) δ: 2.62; 6.99; 7.29; 7.29-7.40; 10.00-11.00.
 30 IR: 3200-2900; 1690-1580 cm⁻¹.
 MS-DIP (70 eV) m/z: 402; 301; 150; 135; 77.
 ANAL: (C₂₈H₂₆N₄OS₂ · 2.5 HI) C: Calcd, 41.07; Found, 41.00. H: Calcd, 3.50; Found, 3.39. N: Calcd, 6.84; Found, 6.67.

35 Example 6 Preparation of *N,N'*-(4-methoxy-1,3-phenylene)bis[*N'*-(4-chlorophenyl)thiourea].



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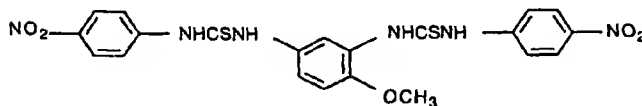
A solution of 4-chlorophenylisothiocyanate (1.43 g, 8.43 mmol) in dry dioxane (20 mL) is added dropwise, under N_2 atmosphere and with constant stirring, to a solution of 4-methoxy-m-phenyldiaminesulfate hydrate (1.00 g, 4.23 mmol) in dry dioxane (25 mL) and in the presence of triethylamine (1.2 mL). After 100 hours of stirring at room temperature, a precipitate appears. This precipitate is filtered and washed with H_2O (5 x 30 mL). The resulting solid is suspended in ethanol (30 mL) and stirred at room temperature for 5 hours. It is then filtered, washed successively with n-hexane (4 x 20 mL) and ethyl ether (4 x 20 mL) and dried. The title compound is obtained as white powder. mp: 114-16 °C.

1H -NMR (DMSO- d_6 , 200 MHz) δ : 3.84; 7.03; 7.23-7.36; 7.52; 8.02; 9.27.

IR: 1594 cm^{-1} .

ANAL: (C₂₁H₁₈Cl₂N₄O₂S₂·H₂O) C: Calcd, 50.91; Found, 50.85. H: Calcd. 4.04; Found, 4.03. N Calcd, 11.31; Found, 11.03.

20 Example 7 Preparation of *N,N'*-(4-methoxy-1,3-phenylene)bis[*N'*-(4-nitrophenyl)thiourea].



25

A solution of 4-nitrophenylisothiocyanate (1.52 g, 8.43 mmol) in dry dioxane (20 mL) is added dropwise, under N_2 atmosphere and with constant stirring, to a solution of 4-methoxy-m-phenyldiaminesulfate hydrate (1.00 g, 4.23 mmol) in dry dioxane (20 mL) and in the presence of triethylamine (1.2 mL). After 120 hours of stirring at room temperature, a yellow precipitate appears. This precipitate is filtered and washed with H_2O (7 x 25 mL). The resulting solid is suspended in IsprOH (25 mL) and stirred at room temperature for 5 hours. It is then filtered and recrystallized. The title compound is obtained as yellow powder. mp: 190-92 °C.

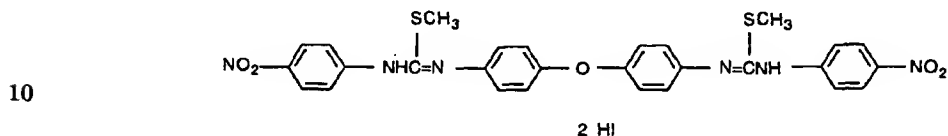
1H -NMR (DMSO- d_6 , 200 MHz) δ : 3.86; 7.09; 7.34; 7.81-8.01; 8.17; 9.68; 10.24-10.53.

IR: 3337; 1606 cm^{-1} .

ANAL: ($\text{C}_{21}\text{H}_{18}\text{N}_6\text{O}_5\text{S}_2$) C: Calcd, 50.60; Found, 50.77. H: Calcd, 3.61; Found, 3.78.

N: Calcd, 16.87; Found, 16.57.

- 5 Example 8 Preparation of dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)carbamimidothioate].



Iodomethane (0.30 g, 2.11 mmol) is added dropwise, with stirring, to a solution of *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)thiourea] (0.50 g, 0.85 mmol) in ethanol (20 mL). After 2 hours of stirring at room temperature, the mixture is heated to reflux for 30 hours, observing total dissolution. This solution is treated, while hot, with active carbon and then filtered. It is concentrated partially until its volume is 10 mL. After 24 hours, a very hygroscopic yellow-orange solid appears. The title compound is obtained as yellow-orange solid. mp: 155-57 °C.

15

20 $^1\text{H-NMR}$ (DMSO-d_6 , 200 MHz) δ ; 2.46; 4.07-4.43; 6.59; 6.95-7.72; 7.74; 7.93; 7.15-7.24; 11.01.

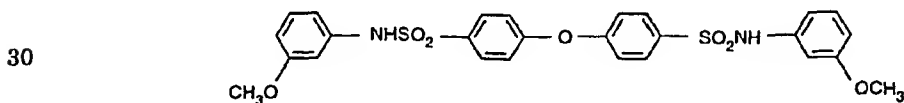
IR: 3200-2900; 1595 cm^{-1} .

ANAL: ($\text{C}_{28}\text{H}_{24}\text{N}_6\text{O}_5\text{S}_2$) C: Calcd, 39.82; Found, 40.32. H: Calcd, 3.08; Found, 3.55.

N: Calcd, 9.95; Found, 9.74.

25

- Example 9 Preparation of bis[*N*-(3-methoxyphenyl)aminosulfonyl](oxydi-4,1-phenylene).



A solution of 4,4'-Bis-(chlorosulfonyl)biphenyl ether (1 g, 2.72 mmol) in dry CH_2Cl_2 (20 mL) is added dropwise, under N_2 atmosphere, to a mixture of *m*-anisidine (1.22 mL, 10.89 mmol) and pyridine (0.44 mL, 5.44 mmol), dissolved in dry CH_2Cl_2 (20 mL) and with magnetic stirring at room temperature. Stirring is

35

maintained at room temperature for 12 days. When this time has elapsed, the solution is concentrated by rotatory evaporation and H₂O (50 mL) is added. The precipitate that forms is then isolated by vacuum filtration. This precipitate is then added to KOH 5% (40 mL). The mixture is stirred magnetically for 1 hour. Next, the mixture is filtered and HCl 35% is then added, until pH=1. The precipitate that forms is collected by vacuum filtration. The title compound is obtained as white powder. mp: 164-65 °C.

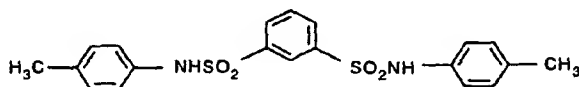
¹H-NMR (DMSO-d₆, 200 MHz) δ: 3.66; 6.59-6.69; 7.10-7.21; 7.80; 10.31.

IR: 3255; 1337; 1254; 1160; 835; 754 cm⁻¹.

MS-DIP (70 eV) m/z: 540; 354; 122; 95.

ANAL: (C₂₆H₂₄N₂O₇S₂) C: Calcd, 57.77; Found, 58.07. H: Calcd, 4.44; Found, 4.59. N: Calcd, 5.18; Found, 5.03.

Example 10 Preparation of *N,N'*-(1,3-phenylene)bis[*N*-(*p*-tolyl)aminosulfonyl].



A solution of 1,3-benzendisulfonyl chloride (1 g, 363 mmol) in dry CH₂Cl₂ (20 mL) is added dropwise, under N₂ atmosphere, to a mixture of p-toluidine (1.55 g, 14.52 mmol) and pyridine (0.59 mL, 7.26 mmol), dissolved in dry CH₂Cl₂ (20 mL) and with magnetic stirring at room temperature. Stirring is maintained at room temperature for 17 days. When this time has elapsed, the solution is concentrated by rotatory evaporation and H₂O (50 mL) is added. The precipitate that forms is then isolated by vacuum filtration. This precipitate is then added to a solution of KOH 5% (50 mL). The mixture is stirred magnetically for 1 hour. Next, the mixture is filtered and HCl 35% is then added, until pH = 1. The precipitate that forms is collected by vacuum filtration. The title compound is obtained as white needles.

mp: 189-90 °C.

¹H-NMR (DMSO-d₆, 200 MHz) δ: 2.19; 6.88; 7.00; 7.68; 7.86; 8.16; 10.32.

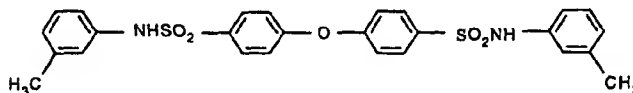
IR: 3246; 1510; 1323; 811; 681 cm⁻¹.

MS-DIP (70 eV) m/z: 416; 246; 106.

ANAL: (C₂₀H₂₀N₂O₄S₂) C: Calcd, 57.69; Found, 57.71. H: Calcd, 4.80; Found, 4.97. N: Calcd, 6.73; Found, 6.79.

Example 11 Preparation of bis[*N*-(3-methylphenyl)aminosulfonyl](oxydi-4,1-phenylene).

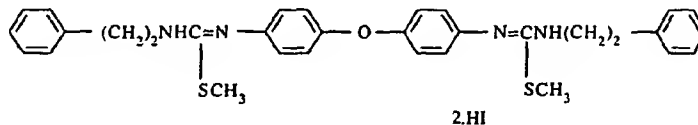
5



A mixture of *m*-toluidine (1.18 mL, 10.89 mmol) and pyridine (0.44 mL, 5.44 mmol) dissolved in dry CH_2Cl_2 (20 mL) is stirred magnetically at room temperature. A solution of 4,4'-bis-(chlorosulphonyl)biphenyl ether (1 g, 2.72 mmol) dissolved in dry CH_2Cl_2 (20 mL) is slowly added dropwise under N_2 atmosphere. Stirring is maintained at room temperature for 15 days. When this time has elapsed, the solution is concentrated by rotatory evaporation and added to a solution of KOH 5% (50 mL). The mixture is stirred magnetically for 1 hour. It is then filtered and HCl 35% is added over the filtrate until pH = 1. The precipitate that forms is collected by vacuum filtration and then washed with a solution saturated with HCO_2K . The title compound is obtained as beige powder. mp 68-69 °C. $^1\text{H-NMR}$ (DMSO-d_6 , 200 MHz) δ 2.18; 6.81-6.90; 7.06-7.18; 7.78. IR: 3256; 1581; 1395; 1329; 1245; 1153; 874; 782 cm^{-1} . MS-DIP (70 eV) m/z : 508; 338; 168; 106. ANAL: ($\text{C}_{26}\text{H}_{24}\text{N}_2\text{O}_5\text{S}_2$) C: Calcd, 61.42; Found, 61.29. H: Calcd, 4.72; Found, 4.70. N: Calcd, 5.51; Found, 5.47.

Example 12 Preparation of dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)carbamidithioate].

30



Iodomethane (0.30 g, 12.0 mmol) is added dropwise, with stirring and at room temperature, to the product of Example 15 (0.50 g) in EtOH (20 mL). The mixture is stirred at room temperature for 2 hours and then is refluxed for 5 hours. The solvent is partially eliminated. After 24 hours at room temperature, a solid appears. The title compound is obtained as cream solid. mp: 192-4 °C.

$^1\text{H-NMR}$ (DMSO-d_6 , 200 MHz) δ (ppm): 2.52; 2.99; 3.71; 7.16; 7.31-7.35; 9.13
10.72.

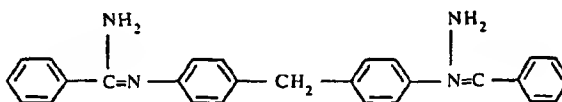
IR (BrK) cm^{-1} : 3200-2900; 1600.

MS-DIP (70 eV) m/z (%): 163; 105.

- 5 Anal ($\text{C}_{32}\text{H}_{34}\text{N}_4\text{OS}_2 \cdot 2\text{HI}$) C: Calcd. 47.42, Found, 47.49; H: Calcd. 4.45, Found, 4.66; N: Calcd, 6.91, Found 6.67.

Example 13 Preparation of N,N' -(methylenedi-4,1-phenylene)bis
[benzenecarboximidamide]

10



- 15 A mixture of 4,4'-diaminodiphenylmethane (1.0 g, 5.37 mmol) and methylbenzimidate hydrochloride (2.05 g, 12.0 mmol) is added slowly, at room temperature, over a stirred solution of glacial acetic acid (1.5 g, 25.0 mmol) and anhydrous sodium acetate (2.05 g, 25.0 mmol) in dioxane (50 mL). The mixture is stirred at room temperature for 48 hours and then poured over H_2O (200 mL) and
- 20 basified with 10% NH_4OH (50 mL). The solid obtained is collected and purified. The title compound is obtained as a white cream solid. mp: 178-9 °C.

$^1\text{H-NMR}$ (DMSO-d_6 , 200 MHz) δ (ppm): 3.86; 6.31; 6.80; 7.16; 7.43; 7.92.

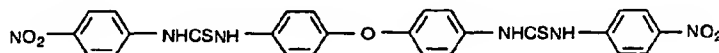
IR (BrK) cm^{-1} : 3354; 1618.

MS-DIP (70 eV) m/z (%): 404; 300; 104.

- 25 Anal ($\text{C}_{27}\text{H}_{24}\text{N}_4$) C: Calcd. 80.19, Found, 79.90; H: Calcd. 5.94, Found, 5.98; N: Calcd, 13.86, Found, 13.96.

Example 14 Preparation of N,N' -(oxydi-4,1-phenylene)bis[N' -(4-nitrophenyl)thiourea].

30



- A solution of 4-nitrophenylisothiocyanate (0.90 g, 5.0 mmol) in dry dioxane
- 35 (30 mL) is slowly added, under nitrogen atmosphere and with stirring, to a solution of 4,4'-diaminodiphenylether (0.50 g, 2.50 mmol) in dry dioxane (30 mL). After 24

hours of stirring at room temperature, a solid appears, which is filtered and washed with n-hexane (3x 25 mL) and Et₂O (3x 25 mL) and purified. The title compound is obtained as yellow power. mp: 156-8 °C.

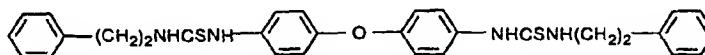
¹H-NMR (DMSO-d₆, 200 MHz) δ 7.06; 7.53; 7.87; 8.24; 10.29; 10.40.

5 IR (BrK) 3323; 1495; 1331 cm⁻¹.

MS-DIP (70 eV) m/z: 242; 200; 180; 138.

ANAL. (C₂₆H₂₀N₆O₅S₂) C: Calcd. 55.71, Found, 55.97. H: Calcd. 3.57; Found, 3.56. N: Calcd, 15.00; Found, 14.69.

10 Example 15 Preparation of *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)thiourea].



15

A solution of 2-phenylethylisothiocyanate (0.81 g, 5.0 mmol) in dry dioxane (20 mL) is added dropwise, under nitrogen atmosphere and with stirring, to a solution of 4,4'-diaminodiphenylether (0.50 g, 2.50 mmol) in dry dioxane (30 mL). After 36 hours of stirring at room temperature, the solvent is removed by vacuum.

20 The residue obtained is stirred for 2 hours with a mixture of 2-propanol/n-hexane (1:1, 50 mL). The solid that precipitates is filtered and purified. The title compound is obtained as white powder. mp: 187-8 °C.

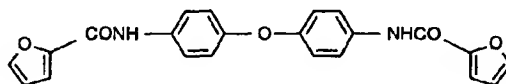
¹H-NMR (DMSO-d₆, 200 MHz) δ 2.87; 3.71; 6.95; 7.27-7.34; 7.66; 9.51.

IR (BrK) 3236; 1345 cm⁻¹.

25 ANAL. (C₃₀H₃₀N₄OS₂) C: Calcd. 68.44; Found 68.45. H: Calcd. 5.70; Found 5.88. N: Calcd. 10.65; Found 10.67.

Example 16 Preparation of *N,N'*-(oxydi-4,1-phenylene)bis(2-furancarboxamide).

30



A mixture of 4,4'-diaminodiphenylether (0.65 g, 3.25 mmol) and
35 triethylamine (0.66 g, 6.53 mmol), dissolved in dry CH₂Cl₂ (15 mL), is stirred magnetically at room temperature. Furan-2-carbonsaurechloride (0.65 g, 4.97 mmol)

dissolved in dry CH_2Cl_2 (5 mL) is added dropwise to the mixture. Stirring is maintained for 2 hours at room temperature. The white precipitate obtained is isolated by vacuum filtration and then washed abundantly with H_2O . The title compound is obtained as white powder. mp: 181.5-182 °C.

5 $^1\text{H-NMR}$ (DMSO-d_6 , 200 MHz) δ : 6.70; 7.01; 7.31-7.33; 7.75; 7.93; 10.22.

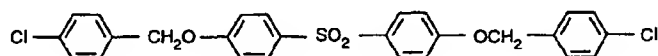
IR: 3273; 3129; 1656; 1274; 832 cm^{-1} .

MS-DIP (70 eV) m/z : 388.05; 293.15; 95.05.

ANAL: ($\text{C}_{22}\text{H}_{16}\text{N}_2\text{O}_5 \cdot 1/2\text{H}_2\text{O}$) C, H, N. C: Calcd, 66.50; Found, 66.51. H: Calcd, 4.28; Found, 4.16. N: Calcd, 7.05; Found, 6.87.

10

Example 17 Preparation of bis(4-chlorobenzoyloxy)(sulfonyldi-4,1-phenylene).



15

Bis(4-hydroxyphenyl)sulfon (1.0 g, 4.0 mmol) is added to a suspension of triturated KOH (2.11 g, 32 mmol) in anhydrous DMSO (30 mL), at room temperature and with magnetic stirring. Immediately afterwards, a solution of 4-chlorobenzoyl chloride (2.57 g, 16 mmol) in dry anhydrous DMSO (20 mL) is added.

20 Stirring is maintained for 24 hours. Next, the mixture is added to water (200 mL) and treated with CH_2Cl_2 (3 x 50 mL). The organic phase is washed with H_2O (2 x 50 mL), dried over anhydrous Na_2SO_4 and filtered. The solvent is vacuum evaporated. The title compound is obtained as white powder. mp: 164-66 °C.

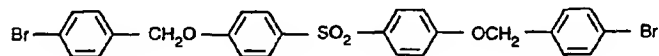
$^1\text{H-NMR}$ (DMSO-d_6 , 200 MHz) δ : 5.18; 7.18; 7.46; 7.86.

25 IR: 1591; 1150; 1105 cm^{-1} .

MS-DIP (70 eV) m/z : 498; 125; 89.

ANAL: ($\text{C}_{26}\text{H}_{20}\text{Cl}_2\text{O}_4\text{S}$) C, H, N. C: Calcd, 62.54; Found, 62.66. H: Calcd, 4.01; Found, 4.16.

30 Example 18 Preparation of bis(4-bromobenzoyloxy)(sulfonyldi-4,1-phenylene).



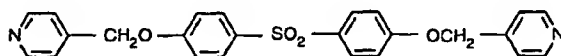
35 Bis(4-hydroxyphenyl)-sulfon (1.0 g, 4.0 mmol) is added to a suspension of triturated KOH (2.11 g, 32 mmol) in anhydrous DMSO (30 mL), at room

temperature and with magnetic stirring. Immediately afterwards, a solution of 4-bromobenzyl bromide (4.0 g, 16 mmol) in anhydrous DMSO (20 mL) is added. Stirring is maintained for 24 hours. Next, the mixture is added to water (200 mL) and treated with CH_2Cl_2 (3 x 50 mL). The organic phase is washed with H_2O (2 x 50 mL), dried over anhydrous Na_2SO_4 and filtered. The solvent is vacuum evaporated. The title compound is obtained as white solid. mp: 183-183.5 °C. $^1\text{H-NMR}$ (DMSO-d_6 , 200 MHz) δ 5.19; 7.18; 7.39; 7.59; 7.85. IR: 1589; 1151; 807; 556 cm^{-1} . MS-DIP (70 eV) m/z: 588; 432; 171; 169.

10 ANAL: ($\text{C}_{26}\text{H}_{20}\text{Br}_2\text{O}_4\text{S}$) C,H,N. C: Calcd, 53.06; Found, 52.79. H: Calcd, 3.40; Found 3.42.

Example 19 Preparation of bis[(4-pyridyl)methoxy](sulfonyldi-4,1-phenylene).

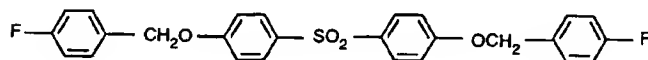
15



A solution of 4-(chloromethyl)pyridine hydrochloride (2.79 g, 17 mmol) in N,N-dimethylformamide (40 mL) is added dropwise to a suspension of bis-(4-hydroxyphenyl)sulfon (2.0 g, 8.0 mmol) and K_2CO_3 (4.72 g, 34 mmol) in N,N-dimethylformamide (40 mL), at room temperature and with magnetic stirring. Stirring is maintained for 24 hours. When this time elapses, K_2CO_3 (4.72 g, 34 mmol) is added and stirring is continued for another 24 hours. After this time has elapsed, the mixture is added over H_2O (200 mL) and the product is taken up with AcOEt (3 x 100 mL). The organic phase is washed with NaOH 2N (3 x 100 mL), distilled H_2O (3 x 100 mL) and HCl 2N (3 x 50 mL). The aqueous fractions obtained from the washings with HCl 2N are collected together and basified with NaOH 10N. The product is taken up with AcOEt (3 x 50 mL) and the organic phase is dried with anhydrous Na_2SO_4 and filtered. The solvent is vacuum dried. The solid obtained is purified by silica gel column [KIESELGEL 60] using AcOEt as the eluent. The title product is obtained as pale brown powder. mp: 182-84 °C. $^1\text{H-NMR}$ (DMSO-d_6 , 200 MHz) δ : 5.00; 6.89; 7.13-7.19; 7.74; 8.50. IR: 3035; 2923; 1592; 1260; 1149; 815 cm^{-1} . MS-DIP (70 eV) m/z: 432; 354; 184; 108; 92.

30 ANAL: ($\text{C}_{24}\text{H}_{20}\text{N}_2\text{O}_4\text{S}$) C,H,N. C: Calcd, 66.67; Found, 66.73. H: Calcd, 4.63; Found, 4.87. N: Calcd, 6.48; Found, 6.41.

Exempl 20 Preparation of bis(4-fluorobenzyloxy)(sulfonyldi-4,1-phenylene).



5

Bis(4-hydroxyphenyl)sulfon (10 g, 4.0 mmol) is added to a suspension of triturated KOH (2.11 g, 32 mmol) in anhydrous DMSO (30 mL), at room temperature and with magnetic stirring. Immediately afterwards, a solution of 4-fluorobenzyl chloride (2.31 g, 16 mmol) in anhydrous DMSO (20 mL) is added. The mixture is stirred for 24 hours. Next, the mixture is poured over H₂O (200 mL) and taken up with CH₂Cl₂ (3 x 50 mL). The organic phase is washed with H₂O (2 x 50 mL), dried with anhydrous Na₂SO₄, and filtered. The solvent is evaporated until dry. The title product is obtained as white powder. mp: 177-177.5 °C.

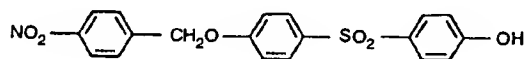
¹H-NMR (Cl₃CD, 200 MHz) δ: 5.04; 7.01; 7.10; 7.37; 7.85.

IR 1593; 1250; 1151; 830 cm⁻¹.

MS-DIP (70 eV) m/z: 466; 358; 250; 109.

ANAL: (C₂₆H₂₀F₂O₄S) C,H,N. C: Calcd, 66.95; Found, 66.99. H: Calcd, 4.29; Found, 4.46. N: Calcd, 0.00; Found, 0.05.

Example 21 Preparation of hydroxy(4-nitrobenzyloxy)(sulfonyldi-4,1-phenylene).



4-Nitrobenzylbromide (1.37 g, 8.5 mmol) is added to a suspension of bis-(4-hydroxyphenyl)sulfon (1.0 g, 4.0 mmol) and triethylamine (0.6 mL, 4.25 mmol) in dry dioxane (25 mL). The mixture is refluxed for 10 hours. After the time elapses, the mixture is left to cool and a dense orange colored oil is obtained. The mixture is poured over distilled H₂O (200 mL) and extracted with CH₂Cl₂ (3 x 50 mL). The organic phase obtained is washed with distilled H₂O (3 x 50 mL), dried with anhydrous Na₂SO₄, and filtered. The solvent is evaporated until dry, and the solid obtained is purified in a silica gel [KIESEL GEL 60] chromatography column using a mixture of toluene/AcOEt (3:1) as the eluent. The title product is obtained as white solid. mp: 203.5-204 °C.

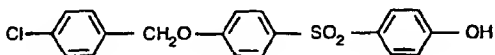
¹H-NMR (DMSO-d₆, 200 MHz) δ 5.37; 6.91; 7.20; 7.69-7.76; 7.84; 8.26; 10.59.

IR: 3332; 1590; 1521; 1345; 1256; 842 cm⁻¹.

MS-DIP (70 eV) m/z : 385; 152; 136; 70.

ANAL: (C₁₉H₁₅NO₆S) C,H,N. C: Calcd, 59.22; Found, 59.17. H: Calcd, 3.90; Found, 3.87. N Calcd, 3.64; Found, 3.52.

5 Example 22 Preparation of (4-chlorobenzoyloxy)hydroxy(sulfonyldi-4,1-phenylene).



10 A solution of 4-chlorobenzyl chloride (1.37 g, 8.5 mmol) is added to a suspension of Bis-(4-hydroxyphenyl)sulfon (2.0 g, 8.0 mmol) and triethylamine (1.2 mL, 8.5 mmol) in dry dioxane (40 mL). The mixture is refluxed for 10 hours. After this time has elapsed, the mixture is left to cool and a dense orange colored oil is obtained. The mixture is poured over distilled H₂O (200 mL) and treated with

15 CH₂Cl₂ (3 x 50 mL) The organic phase obtained is washed with NaOH 2N (3 x 50 mL). Later, the aqueous extracts are joined together and neutralized with HCl (2N) The precipitate obtained is isolated by vacuum filtration and purified in a silica gel [KIESEL GEL 60] chromatography column using a mixture of toluene/AcOEt (3:1) as the eluent. The title product is obtained as white powder. mp: 146-47 °C.

20 ¹H-NMR (DMSO-d₆, 200 MHz) δ : 5.18; 6.91; 7.17; 7.44-7.46; 7.73; 7.82; 10.58.

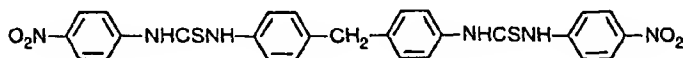
IR: 3411; 1589; 1249; 836; 569 cm⁻¹.

MS-DIP (70 eV) m/z : 374; 141; 125.

ANAL: (C₁₉H₁₅Cl₂O₄S) C,H,N. C: Calcd, 60.89; Found, 61.35. H: Calcd, 4.01; Found 4.16.

25

Example 23 Preparation of *N, N'*-(methylenedi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)thiourea].



30

A solution of 4-nitrophenyl isothiocyanate (0.45 g, 2.52 mmol) in dioxane (25 mL) is slowly added, with magnetic stirring, to a solution of 4,4'-diaminodiphenyl methane (0.25 g, 1.26 mmol) in dioxane (10 mL). After 24 hours of stirring at room

35 temperature, the solvent is removed by vacuum evaporation. The solid obtained is washed with *n*-hexane (3 x 25 mL) and isopropanol (3 x 10 mL). Next, the solid is

dissolved in ethyl acetate (50 mL) and washed with water (3 x 25 mL). The organic phase is dried with sodium sulfate. The solvent is removed by vacuum evaporation.

The titled compound is obtained as a yellow powder. mp: 115 °C.

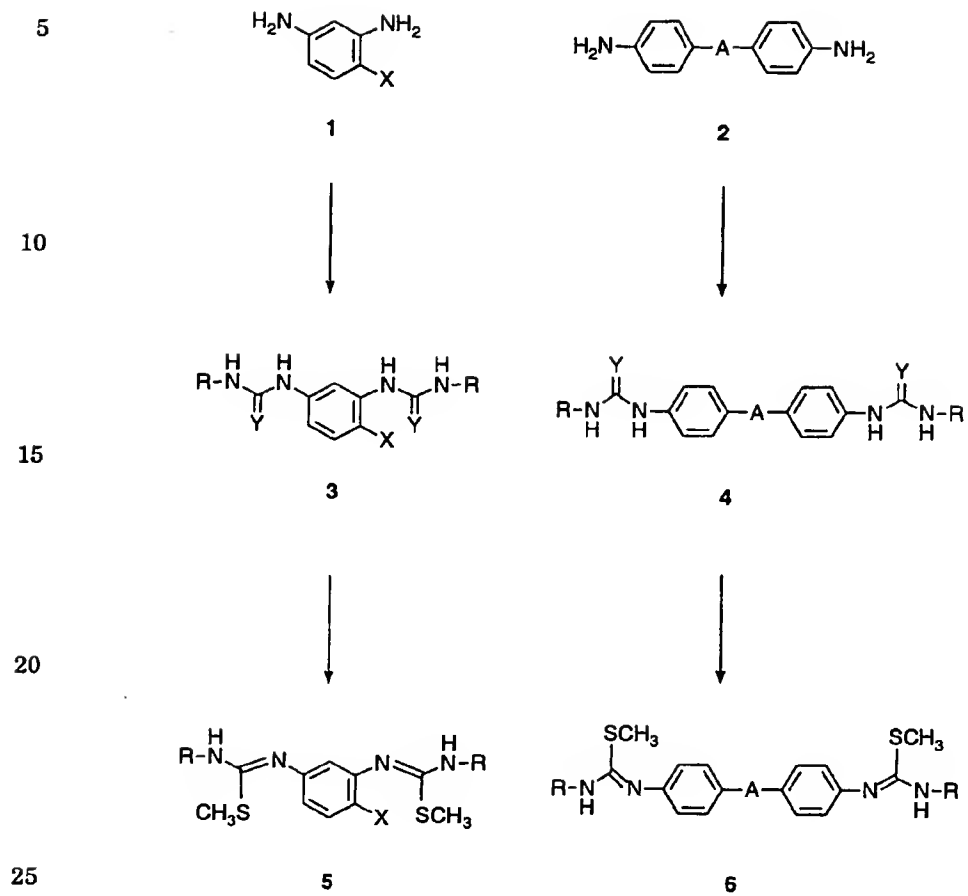
¹H-NMR (DMSO-d₆) δ 3.90; 7.24; 7.39; 7.82; 8.19; 10.22; 10.34.

5 IR: 3410; 1500; 1327 cm⁻¹.

MS-DIP (70 eV) m/z: 180.05

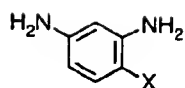
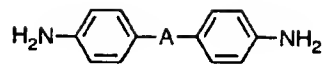
ANAL: (C₂₇H₂₂N₆O₄S₂) C,H,N. C: Calcd, 58.06; Found, 58.06. H: Calcd, 3.94; Found, 4.15. N: Calcd, 15.05; Found, 14.71.

SCHEME 1A

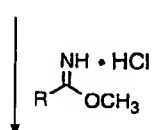
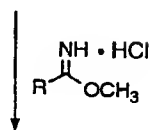


SCHEME 1B

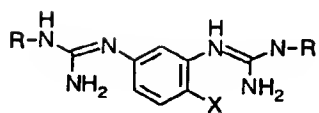
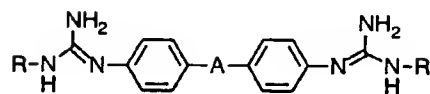
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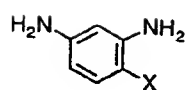
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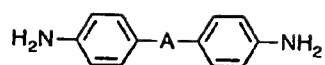
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SCHEME 1C

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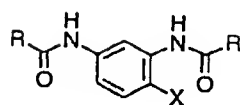


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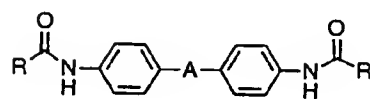
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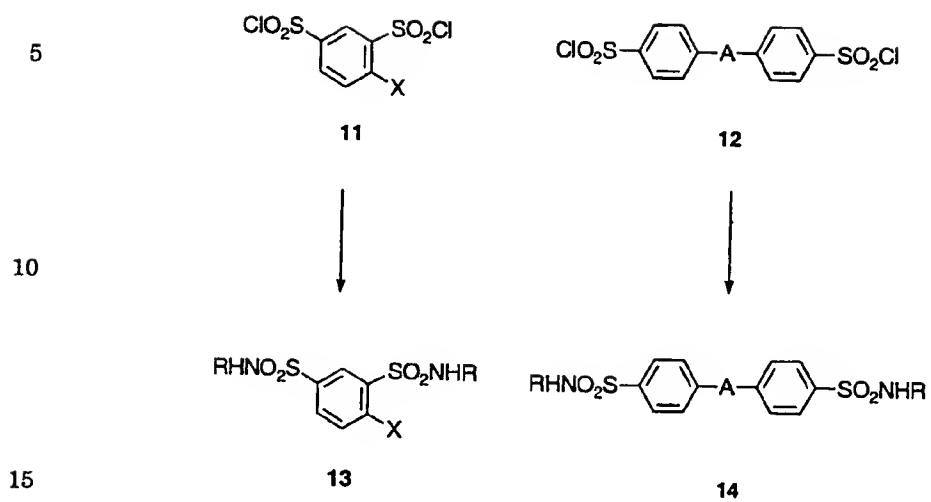


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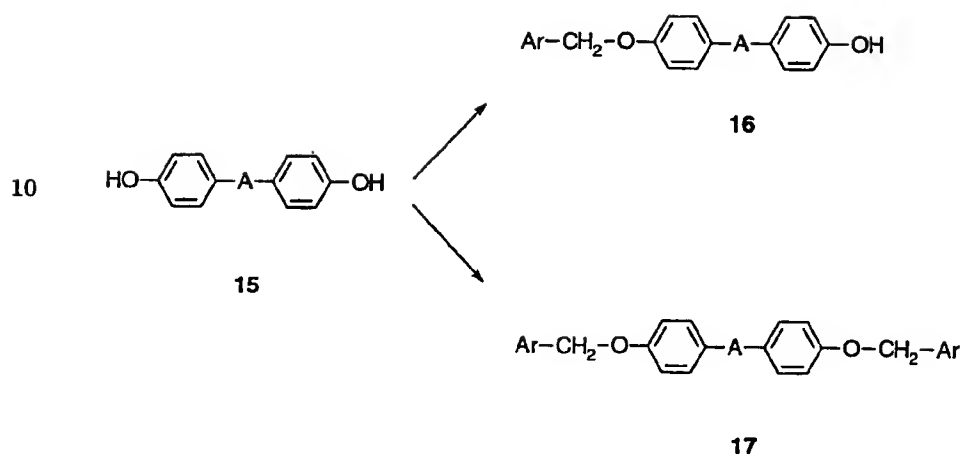
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SCHEME 2



SCHEME 3

5

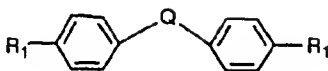


CLAIMS

We claim:

1. A compound of formula I

5



I

or pharmaceutically acceptable salts thereof wherein:

10 Q is

- (a) -O-, or
- (b) -CH₂-;

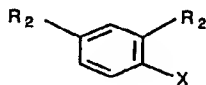
R₁ is

- (a) -N=C(SCH₃)(NH-phenyl),
- 15 (b) -N=C(SCH₃)(NHCH₂CH₂-phenyl),
- (c) -N=C(SCH₃)(NH-4-nitrophenyl),
- (d) -N=C(SCH₂CH₃)(NHCH₂CH₂-phenyl),
- (e) -SO₂NH(3-methoxyphenyl),
- (f) -SO₂NH(3-methylphenyl), or
- 20 (g) -N=C(NH₂)(phenyl);

with the following provisos:

- (a) where Q is -O-, R₁ and R₂ are other than (g), and
- (b) where Q is -CH₂-, R₁ and R₂ are other than (a) - (f).

25 2. A compound of formula II



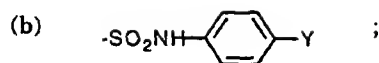
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II

or pharmaceutically acceptable salts thereof wherein:

R₂ is

- 35 (a) $\text{-NH-C(=W)-NH-C}_6\text{H}_4\text{-Y}$, or



W is

- 5 (a) =O, or
(b) =S;

X is

- (a) -H,
(b) -CH₃, or
10 (c) -OCH₃;

Y is

- (a) -CH₃,
(b) -Cl, and
(c) -NO₂.

15

3. A compound of formula I according to claim 1 which is

- a) Dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(phenyl)carbamimidothioate],
- b) Dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)
- 20 carbamidimidothioate],
- c) Dimethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)
- carbamimidimidothioate],
- 25 d) Diethyl *N,N'*-(oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)carbamimidimidothioate],
- e) Bis[*N'*-(3-methoxyphenyl)aminosulfonyl](oxydi-4,1-phenylene),
- f) Bis[*N'*-(3-methylphenyl)aminosulfonyl](oxydi-4,1-phenylene), or
- 30 g) *N,N'*-(Methylenedi-4,1-phenylene)bis[benzenecarboximidamide].

4. A compound of formula II according to claim 2 which is

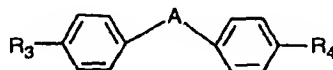
- a) *N,N'*-(4-Methoxy-1,3-phenylene)bis[*N'*-(4-nitrophenyl)urea],
- 35 b) *N,N'*-(4-Methoxy-1,3-phenylene)bis[*N'*-(4-chlorophenyl)urea],

- c) N,N'' -(4-Methoxy-1,3-phenylene)bis[N' -(*p*-tolyl)urea],
- d) N,N'' -(4-Methyl-1,3-phenylene)bis[N' -(4-chlorophenyl)thiourea],
- 5 e) N,N'' -(4-Methoxy-1,3-phenylene)bis[N' -(4-chlorophenyl)thiourea],
- f) N,N'' -(4-Methoxy-1,3-phenylene)bis[N' -(4-nitrophenyl)thiourea], or
- g) N,N'' -(1,3-Phenylene)bis[N -(*p*-tolyl)aminosulfonyl].

10

5. A use of a compound of formula III or pharmaceutically acceptable salts for treating herpes virus infection in patients which comprises topically administering to the herpetic lesion on the skin of said patients an effective amount of a compound of formula III

15



III

20 or pharmaceutically acceptable salts thereof wherein:

A is

- (a) -O-,
- (b) -CH₂, or
- (c) -S(=O)₂-;

25 R₃ and R₄ are the same and are

- (a) -N=C(SCH₃)(NH-phenyl),
- (b) -N=C(SCH₃)(NHCH₂CH₂-phenyl),
- (c) -N=C(SCH₃)(NH-4-nitrophenyl),
- (d) -N=C(SCH₂CH₃)(NHCH₂CH₂-phenyl),
- 30 (e) -SO₂NH(3-methoxyphenyl),
- (f) -SO₂NH(3-methylphenyl),
- (g) -N=C(NH₂)(phenyl),
- (x) -NHC(=O)(2-furyl),
- (i) -NHC(=S)NHCH₂CH₂-phenyl,
- 35 (j) -NHC(=S)NH(4-nitrophenyl),
- (k) -OCH₂(4-bromophenyl),

- (l) $-\text{OCH}_2(4\text{-chlorophenyl})$,
- (m) $-\text{OCH}_2(4\text{-fluorophenyl})$,
- (n) $-\text{OCH}_2(4\text{-pyridyl})$,

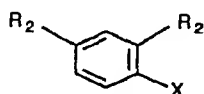
R_3 and R_4 are different and are

- 5 (o) $-\text{OH}$,
- (p) $-\text{OCH}_2(4\text{-chlorophenyl})$, or
- (q) $-\text{OCH}_2(4\text{-nitrophenyl})$;

with the following provisos:

- (a) where A is $-\text{O}-$, R_3 and R_4 are other than (k) - (q),
- 10 (b) where A is $-\text{CH}_2-$, R_3 and R_4 are (g) or (j), and
- (c) where A is $-\text{S}(=\text{O})_2-$, R_3 and R_4 are other than (a) - (j).

6. A use of a compound of formula II or pharmaceutically acceptable salts for treating herpes virus infection in patients which comprises topically administering to the herpetic lesion on the skin of said patients an effective amount of a compound of formula II



II

or pharmaceutically acceptable salts thereof wherein:

R_2 is

- 25 (a) $-\text{NH}-\overset{\text{W}}{\underset{\text{H}}{\text{C}}}-\text{NH}-$, or

- (b) $-\text{SO}_2\text{NH}-$;

30 W is

- (a) $=\text{O}$, or
- (b) $=\text{S}$;

X is

- (a) $-\text{H}$,
- 35 (b) $-\text{CH}_3$, or
- (c) $-\text{OCH}_3$;

Y is

- (a) $-\text{CH}_3$,
- (b) $-\text{Cl}$, and
- (c) $-\text{NO}_2$.

5

7. A compound of formula III according to claim 5 which is

- a) Dimethyl *N,N''*-(oxydi-4,1-phenylene)bis[*N'*-(phenyl)carbamimidothioate],
- b) Dimethyl *N,N''*-(oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)
- 10 carbamidimidothioate],
- c) Dimethyl *N,N''*-(oxydi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)
- carbamimidothioate],
- 15 d) Diethyl *N,N''*-(oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)carbamimidothioate],
- e) Bis[*N'*-(3-methoxyphenyl)aminosulfonyl](oxydi-4,1-phenylene),
- f) Bis[*N'*-(3-methylphenyl)aminosulfonyl](oxydi-4,1-phenylene),
- 20 g) *N,N''*-(Methylenedi-4,1-phenylene)bis[benzenecarboximidamide],
- h) *N,N''*-(Oxydi-4,1-phenylene)bis(2-furancarboxamide),
- 25 i) *N,N''*-(Oxydi-4,1-phenylene)bis[*N'*-(2-phenylethyl)thiourea],
- j) *N,N''*-(Oxydi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)thiourea],
- k) *N,N''*-(Methylenedi-4,1-phenylene)bis[*N'*-(4-nitrophenyl)thiourea],
- 30 l) Bis(4-bromobenzyloxy)(sulfonyldi-4,1-phenylene),
- m) Bis(4-chlorobenzyloxy)(sulfonyldi-4,1-phenylene),
- 35 n) Bis(4-fluorobenzyloxy)(sulfonyldi-4,1-phenylene),

- o) Bis[(4-pyridyl)methoxy](sulfonyldi-4,1-phenylene),
- p) (4-Chlorobenzyloxy)hydroxy(sulfonyldi-4,1-phenylene), or
- 5 q) Hydroxy(4-nitrobenzyloxy)(sulfonyldi-4,1-phenylene).
8. The use of compounds according to claim 5 or 6 wherein the herpes virus infection is herpes simplex type-1.
- 10 9. The use of compounds according to claim 5 or 6 wherein the herpes virus infection is herpes simplex type-2.
10. The use of compounds according to claim 5 or 6 wherein the herpes virus infection is varicella zoster virus.
- 15 11. The use of compounds according to claim 5 or 6 wherein the effective amount is administered topically in a pharmaceutical composition.
12. A pharmaceutical composition for treating herpes viral infections in patients
- 20 which comprises a compound of formula II or III and a pharmaceutically acceptable carrier.
13. The pharmaceutical composition of claim 12 wherein said compound of formula II or formula III is present in an amount of about 0.05% to about 25% by
- 25 weight.
14. The pharmaceutical composition of claim 12 wherein said compound of formula II or III is present in an amount of about 0.1% to about 10% by weight.